CALIFORNIA DIVISION OF MINES AND GEOLOGY

FAULT EVALUATION REPORT FER-88

March 19, 1979

1. Name of fault

Hayward, Mission and Calaveras faults, segments in Niles quadrangle.

2. Location of faults

Niles 7.5-minute quadrangle, Alameda County (see Figure 1).

3. Reason for evaluation

Request from City of Fremont to delete Special Studies Zone encompassing Mission fault (letter from Larry Milnes to State Geologist, January 30, 1979).

4. References

Not alphabetized

Radbruch, D.H., 1968, Map showing recently active breaks along the Hayward Fault Zone and the southern part of the Calaveras Fault Zone, California: U.S. Geological Survey, Open File Map, 1:24,000. (2 sheets).

Radbruch, D.H., 1967, Approximate location of fault traces and historic surface ruptures within the Hayward fault zone between San Pablo and Water Springs, California: U.S. Geological Survey Misc. Geol. Inv., Map I-522, 1:62,500.

Radbruch-Hall, D.H., 1974, Map showing recently active breaks along the Hayward fault zone and the southern Calaveras fault Zone, California: U.S. Geological Survey Misc. Investigation Series Map I-813, 1:24,000 scale.

U.S. Geological Survey, 1966, Tectonic creep in the Hayward Fault Zone: Circular 525, 13p. (Articles by Bonilla and by Cluff and Steinbrugge identify creep localities in the Niles quad; more detailed articles also published in Bull. of SSA, April 1966, p. 257-289.)

U.S. Geological Survey, 1966, Aerial photos WRD 3435 to 3448, 3471 to 3482, 4171 to 4175, and 4200-4204, black and white, vertical, scale Approx. 1:7,000.

U.S. Soil Conservation Service, 1939, Aerial photographs, BUT 181-8 and -9, BUT 281-23 to-30, BUT 281-50 to-53, and BUT 281-74 and-75, black and white, vertical, scale 1:24,000.

Woodward-Clyde Consultants, 1976, Alquist-Priolo Special Studies Zone report, Shinn property, Tract 3613, Fremont, C A.: Unpublished consulting report of July 27, 1976 (Project 70037A), 13p., 11 figs. plus supplement of August 30, 1976. (Same as AP- 380.)

Woodward-Clyde-Sherard and Associates, 1964, Soil and geology feasibility study, VII Hills Development, Alameda County, California: Unpublished consulting report for Eastland Construction Company. (CDMG file report C-10.)

Woodward-Clyde-Sherard and Associates, 1968, Earthquake fault and earthquake engineering studies, Huddleson Site, Ohlone College: Unpublished report for Ohlone College. (CDMG file report C-12.)

Woodward-Lundgren and Assoc., 1974, Review of geologic/seismic report, Masonic Homes of California, Union City, California: Unpublished consulting report for Masonic Homes of California, 11 p., maps, aerial photos. (CDMG Hospital File No H-0120; also C-20.)

Crittenden, M.D., Jr., 1951, Geology of the San Jose-Mount Hamilton area, California Div. of Mines Bull. 157, 74p. Pl. 1. (1:62,500).

Dibblee, W.W.,Jr., 1972, Preliminary geologic map of the Calaveras Reservoir and Milpitas quadrangles, Alameda and Santa Clara Counties, California: U.S. Geological Survey Open-file Maps, 1:24,000 scale.

Dibblee, T.W., Jr., 1973, Preliminary geologic map of the Calaveras Reservoir quadrangle, Alameda and Santa Clara Counties, California: U.S. Geological Survey Open-file map, 1:24,000 scale.

Hall, C.A., 1958, Geology and paleontology of the Pleasanton area, Alameda and Contra Costa Counties: Univ. of California Press, Berkeley and Los Angeles, 63p., map (1:40,000±) (almost same as PhD thesis of 1956).

Heffern, E.L., 1973, Geology of Mission Peak and vicinity, Alameda County, California: Unpublished (graduate?) student report, Geology 400 Research Project, Stanford University(?), 40p., map (1:24,000 scale).

Herd, Darrell, 1978, Map of Quaternary faulting along the northern Calaveras Fault Zone: U.S. Geological Survey Open-file report 78-307, Sheet 4 of 5 (Niles quadrangle).

Lee, W.H.K. and 6 others, 1972, Seismicity map of greater San Francisco Bay area, California, 1969-1971: U.S. Geological Survey Open-file map.

Levish, M., 1973, Unpublished fault map of portions of the Niles, Dublin, and La Costa Valley quadrangles: C.D.M.G. file data. (Little justification is provided in these notes that documents position of the traces or the recency of faulting.)

Nason, R.D., 1971, Investigation of fault creep slippage in northern and central California: Unpublished PhD thesis, Univ. of California at San Diego, 231p.

Nilsen, T.H., 1973, Preliminary photointerpretation map of landslide and other surficial deposits of the Livermore and part of the Hayward 15-minute quadrangles, Alameda and Contra Costa Counties, California: U.S. Geological Survey Misc. Field Studies Map MF-519.

Pacific Resources, Inc., 1970, Aerial photos AV-950-01-54 to 59, vertical, black and white, 1:12,000 scale.

5. Review of available data, air photointerpretation, field checking

The Special Studies Zones (SSZ) of 1974, depicted on the Niles quadrangle, were based on fault traces referenced on Figure (2). Inadverdently omitted from the Official SSZ Map reference list is Radbruch (1968), used as the principal source of traces for the Hawyard fault and the branch fault that was inferred to interconnect with the Mission fault.

The SSZ encompassing the Mission fault was based on mapping of Hall (1958) and the fact that Woodward-Clyde-Sherard and Assoc. (1964) classified the fault as "active". The structural relationship to the active (1868) Hayward fault and the possibly active, inferred branch fault of Radbruch (1968) supported the decision to zone the Mission fault. In contrast, Radbruch (1968) did not show recently active breaks for the Mission fault, Woodward-Clyde-Sherard and Assoc. (1968) classified the Missim

fault as "inactive", and Hall (1958) portrayed the fault as not cutting Pleistocene terrace deposits. According to the Woodward-Clyde-Sherard and Assoc. (1968, P. 14), Hall did not consider the Mission fault to be active.

Other data acquired since that time indicates that the Mission fault is not active and its trace cannot be located in the younger alluvial deposits or even the Pleistocene Irvington Gravels. Specifically, Herd (1978) did not map the Mission fault as a Quaternary fault. He stated (personal communication March 5, 1979)"that there is no evidence of Holocene faulting and there is no support for the positioning of a Quaternary Mission fault." In addition, trenching conducted by consulting geologists at 10 development sites within the Niles quadrangle (see Figure 2 for trench locations and report identifications) failed to uncover evidence for faulting along the Mission fault trace in any of the Quaternary alluvial and colluvial units. Most comprehensive of these is the Woodward-Clyde-Sherard (1972, p. 15-16) report, quoted below:

"In looking for evidence to support the existence of the Mission fault we have studied the areas for several miles north and south of the Huddleson site. Where the fault is shown to definitely exist by previous workers, we can find no positive field evidence for its existence. We have discussed this point with Dr. Clarence Hall-UCLA, whose geologic map is the most recent and detailed in this area. Dr. Hall stated that "Most of his evidence for the existence and location of the Mission fault was suggestive and not conclusive." He further stated that, "his primary evidence was based on physiography, and that the abrupt topographic expression along the west side of Mission Peak, extending toward the northwest was probably a fault-line-scarp, and if a fault did exist it would be located to the west." He also said "if the Mission fault does exist it should not be considered as an active earthquake fault.""

"We have also discussed this same point with Dr. Max Crittenden of the U.S. Geological Survey who has mapped the geology to the south of Mission Peak. Dr. Crittenden states that "he does not show the Mission fault on his geologic map of the Mount Hamilton Quadrangle because he could not find evidence for its existence in the field." He said that "the topographic expression along the west side of Mission Peak could be explained other than by faulting." He suggested that "possibly differential erosion between hard and soft formations could have produced the topographic scarp.""

"We have also conducted extensive field investigations in the area supposedly traversed by the Mission fault beyond the limits of the Huddleson site and have come to the following conclusions:

(1) The existence and/or location of the Mission fault appears impossible to prove conclusively, especially across the Huddleson site. If it does exist, it must cross the site somewhere west of Test Boring No. 10, Figure 4. If it does cross the site in this area, it is overlain by approximately 100 feet of alluvial material including the Irvington formation as shown in Figures 4 and 5.

(2) Presuming the Mission fault does exist, there is no evidence to suggest it has been active in recent geological time, as we find no indication of a surface expression of the fault in this area. Therefore, we do not consider it to be an active earthquake fault."

Dibblee (1973) also mapped the Mission fault in Miocene bedrock in the Calaveras Reservoir quadrangle to the southeast, but he does not indicate that it cuts any alluvial unit (Qa on his map). Northwest of Alameda Creek, the two traces of the Mission fault are not traceable as well-defined features on aerial photos. My observations based on photointerpretation (Figure 3) are that the escarpment west of Mission Peak is almost certainly due to ancient faulting. However, active and massive landsliding obscures the precise location and recency of faulting. Massive sliding is verified by Nilsen (1973), Herd (1978), Heffern (1973), and Hall (1958).

Another consideration is the microseismicity that coincides with the trace of the Mission fault. This is shown by Lee et al.(1972) and is reproduced as Figure 4. It is tempting to assume that the microseismicity of the Hayward fault transfers to the Calaveras fault via the Mission Creek fault. However, there may be a systematic travel-time error in the epicenters plotted, the Hayward and Calaveras faults may actually dip to the northeast, and the Mission fault probably dips steeply northeast (Hall, 1958). Thus, the epicenter data does not mandate activity on the Mission fault, although historic faulting (at depth) cannot be refuted.

The inferred active fault of Radbruch (1968), shown on Figure 2 as the approximately located fault that crosses Agua Caliente Creek, is not mapped by other geologists who have done independent mapping. According to Herd (1978), the reported ground cracks associated with the 1868 earthquake apparently were "associated with landsliding, not surface faulting". Interpretation of aerial photos (Figure 3), clearly indicate recently active, massive landsliding in the vicinity of the landslide deposits of Herd. No topographic

lineament is observable along the inferred trace shown by Radbruch. Moreover, this fault is not mapped in the adjacent Milpitas quadrangle by Dibblee (1972).

Both the Mission fault and the inferred active fault of Radbruch were studied in the Mission Peak area by Heffern (1973), a graduate student at Stanford. He concluded that landsliding was an over-riding geologic process and neither the existence nor the activity could be proved or disproved for these inferred faults.

The Hayward fault traces shown and zoned on the 1974 SSZ Map of the Niles quadrangle (Figure 2), were based on the mapping of Radbruch (1968), Levish (1973), and Woodward-Lundgren (1974). Additional data on the recently active traces show some disagreement in the detailed locations of traces (Herd, 1978; this report). However, 16 site investigations employing trench exploration (see Figure 2 for trench locations and report identifications) show that Radbruch's traces largely identified the most active faults. It is noted that Radbruch's traces were mislocated on the SSZ map (drafting errors) by as much as 200 feet. Also, Radbruch slightly modified her data and trace locations in later report (Radbruch-Hall, 1974) and any revised SSZ maps should replot her traces using the latest map. My own photointerpretation and limited field checking (Figure 3) generally supports the work of Radbruch-Hall and Herd, but we differ locally in detail. With the exception of the area southeast of Durham Road, the recently active strands of the Hayward fault are well-defined and a slightly narrower SSZ could be drawn than exists for the 1974 zone map.

The small SSZ located at the south boundary of the quadrangle 4,000 feet east of the Hayward fault was delineated based on an inferred fault mapped by Dibblee (1972) in the adjuacent Milpitas quadrangle. This fault offsets the Santa Clara Formation (of late Pliocene or early Pleistocene age) but not the younger alluvium. There is no evidence that this inferred fault is Holocene active and no geologist has mapped this fault as active or potentially active (see Radbruch-Hall, 1974; Herd, 1978). Pre-grading aerial photographs (U.S. Soil Conservation, 1939) reveal no evidence of active fault features in the SSZ shown on the Niles quadrangle and a site investigation did not reveal an active fault (Figures 2 and 3).

The Calaveras fault and SSZ shown on the northeastern part of Figure 2 were based on the mapping of Hall (1958) and Levish (1973). Hall largely showed the fault as concealed within the Niles quadrangle. The general location of his trace apparently is controlled by deformed and truncated units of Miocene and older rocks (Hall, geologic map and p. 39-41). Hall (p.40) states that the Plio-Pleistocene Livermore Gravels are "apparently undisturbed". However, he indicates on his map that Livermore Gravels are in fault contact with Briones Formation just south of Arroyo de la Laguna. Apparently this is a drafting error. The other three fault traces are attributed to Levish (p.c. 1973). There is no documentation justifying the position or recency of these faults in the file notes of CDMG.

Herd (1978) mapped traces of the Calaveras fault approximately along the southwestern trace of Levish (Figure 2). He indicates that landslides obscure the fault to the north. However, he believes (Herd, 1979, p.c.) that serpentine float (there are no outcrops) in the landslide area indicates

that the fault lies relatively high on the northeast flank of Pleasanton Ridge. He further indicated that there is no evidence for Levish's easterly trace on 1939 aerial photos.

My interpretation of the 1939 photos (U.S. Soil Conservation) closely coincides with that of Herd, except that I believe the recent trace of the Calaveras fault can be observed an additional 3,000 feet to the north before it is obscured by landslides. Other traces of the fault may exist downslope, but they cannot be detected on the 1939 photos.

The projected SSZ south of Highway 680 and along the margin of the map is based on unpublished mapping of Levish (p.c., 1973) in the adjacent La Costa Valley quadrangle. He shows a fault along the southwest margin of Sunol Valley just east of the Niles quadrangle, but he provides no documentation for the fault's position or recency. Aerial photos (USGS, 1967) reveal no specific evidence of this fault in the Niles quadrangle and only permissive evidence for quaternary faulting in the adjacent La Costa Valley quadrangle. Neither Herd (1978) nor Hall (1958) shows a fault in this area.

6. Conclusions

a. Mission fault: There is no evidence for Holocene (or even late Quaternary) faulting northwestward from Sec. 6, T. 4S, R. 1E., near Mission San Jose. Specific site investigations (including trenching, Figure 2) have not revealed the existence of recently active faults. Southeast of Sec. 6, an escarpment (fault-line scarp?) generally suggest an ancient fault, but historic and Holocene landsliding obscures the activity and the precise location of any Holocene fault strands that may exist. There is no evidence that the Mission fault is active.

b. Branch fault of Radbruch (west of Warm Spring): This fault was inferred to exist because of possible ground ruptures reported in 1868 (Radbruch, 1968). No one else has mapped this fault, whose inferred trace lies in a landslide area (at least north of Agna Caliente Creek) (see Figures 2 and 3; Herd, 1978; Hall, 1958; Heffern, 1973).

c. Hayward fault: The position of the most recent traces and activity (historic and Holocene) are well-established. The recently active traces lie totally within the established SSZ, but are not always accurately identified on the 1974 SSZ map.

d. Projected fault and SSZ south of Warm Springs: There is no evidence for recent faulting here.

e. Calaveras fault: Only the westernmost pair of the traces shown on the 1974 SSZ map are believed to be Holocene. These traces are relocated based on the works of Herd (1978) and me (this report, Figure 3). There is no evidence for the other traces (based on Levish, 1973), although they could be obscured by recent landsliding and stream erosion/deposition. There is no need to have more than one active trace (the westerly one shown), although the absence of other active traces cannot be demonstrated.

g. Calaveras branch fault (SE of Highway 680): There is no evidence of faulting in the alluvium of the Niles quadrangle (Herd, 1978 and p.c. 1979; Hall, 1958). Only weak evidence for Levish's (1973) Quaternary faulting is apparent on aerial photos within the adjacent La Costa Valley quadrangle. Even so, there is no specific evidence Holocene faulting in the latter area along the SW side of Sunol Valley.

7. Recommendations:

a. Mission fault: Delete the existing SSZ and fault traces.

b. Branch fault of Radbruch: Delete the existing SSZ and fault trace.

c. Hayward fault: Revise the existing SSZ based on the work of Radbruch-Hall (1974), Herd (1978), and this report. A somewhat narrower zone can be delineated over most of the length of this fault.

d. Projected fault and SSZ south of Warm Springs: Delete the SSZ shown.

e. Calaveras fault: Revise fault traces based on the work of Herd (1978) and this report. This zone should be drawn amply wide to account for uncertainties on the northward projection and on the possible presence of active branches in the landslide downslope from the mappable traces.

f. Calaveras branch fault (S.E. of Highway 680): Delete SSZ; no evidence for Holocenefaulting in Niles quadrangle or adjacent area to southeast.

8. Report prepared by E. W. Hart, 3/19/79.

E. W. Hart

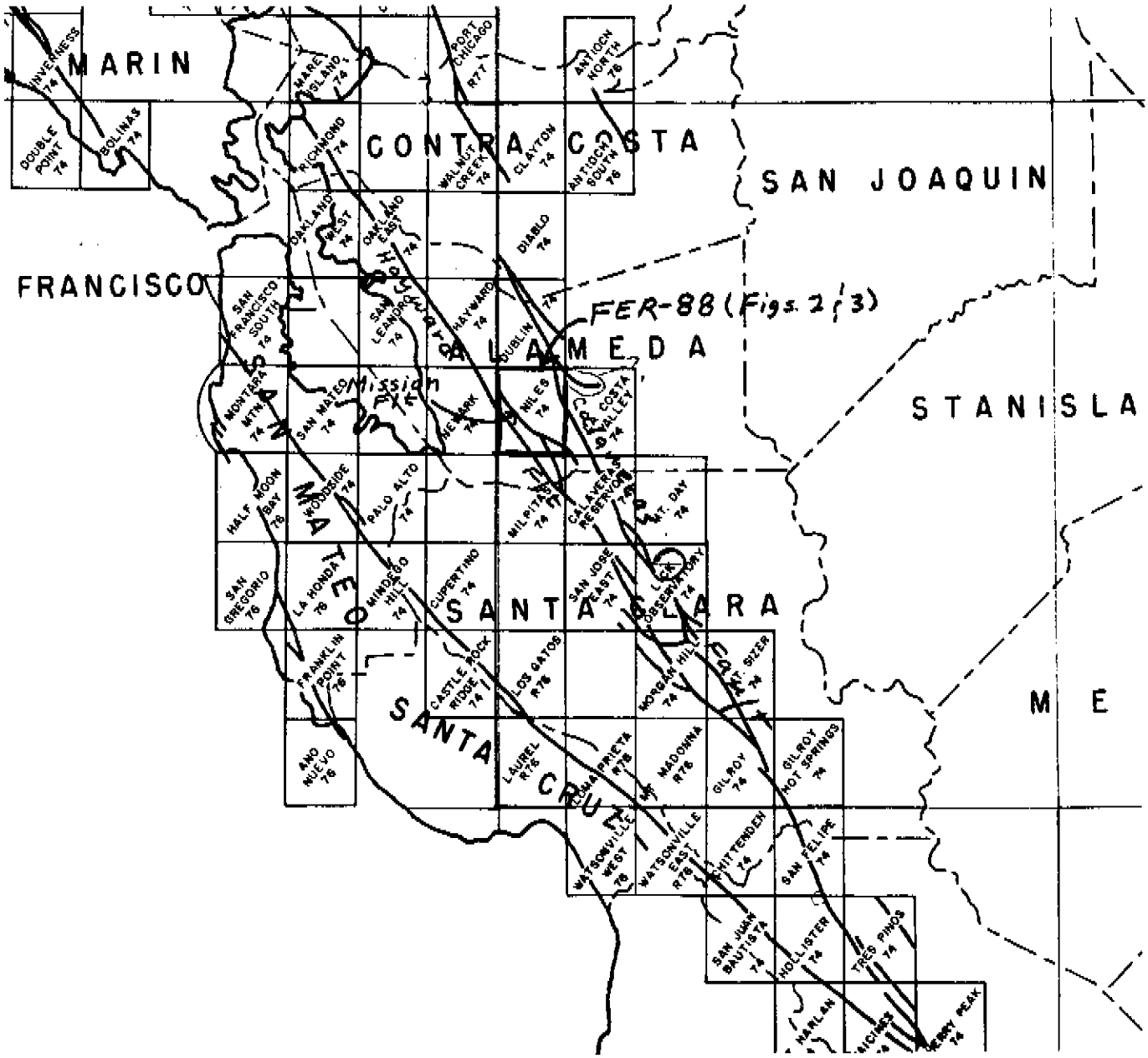

Figure 58. Index to maps of Special Studies Zones.

EXPLANATION

Faults zoned for special studies

Quadrangle name of Official Map; number indicates year issued (74=1974); R indicates a Revised Official Map

NOTE: Data used to delineate special studies zones are subject to continual review. Future revisions and additions may be made by the State Geologist. The latest index map should be consulted for information on the availability of special studies zones maps. Further information is available from the State Geologist, California Division of Mines and Geology, Room 1341, 1416 Ninth Street, Sacramento, CA, 95814.

Scale 1:1,000,000

1 inch equals approximately 16 miles

Figure 1 (to FER-88). Index to main faults and special Studies Zones, Niles quadrangle (from special Publication 42, p. 13).

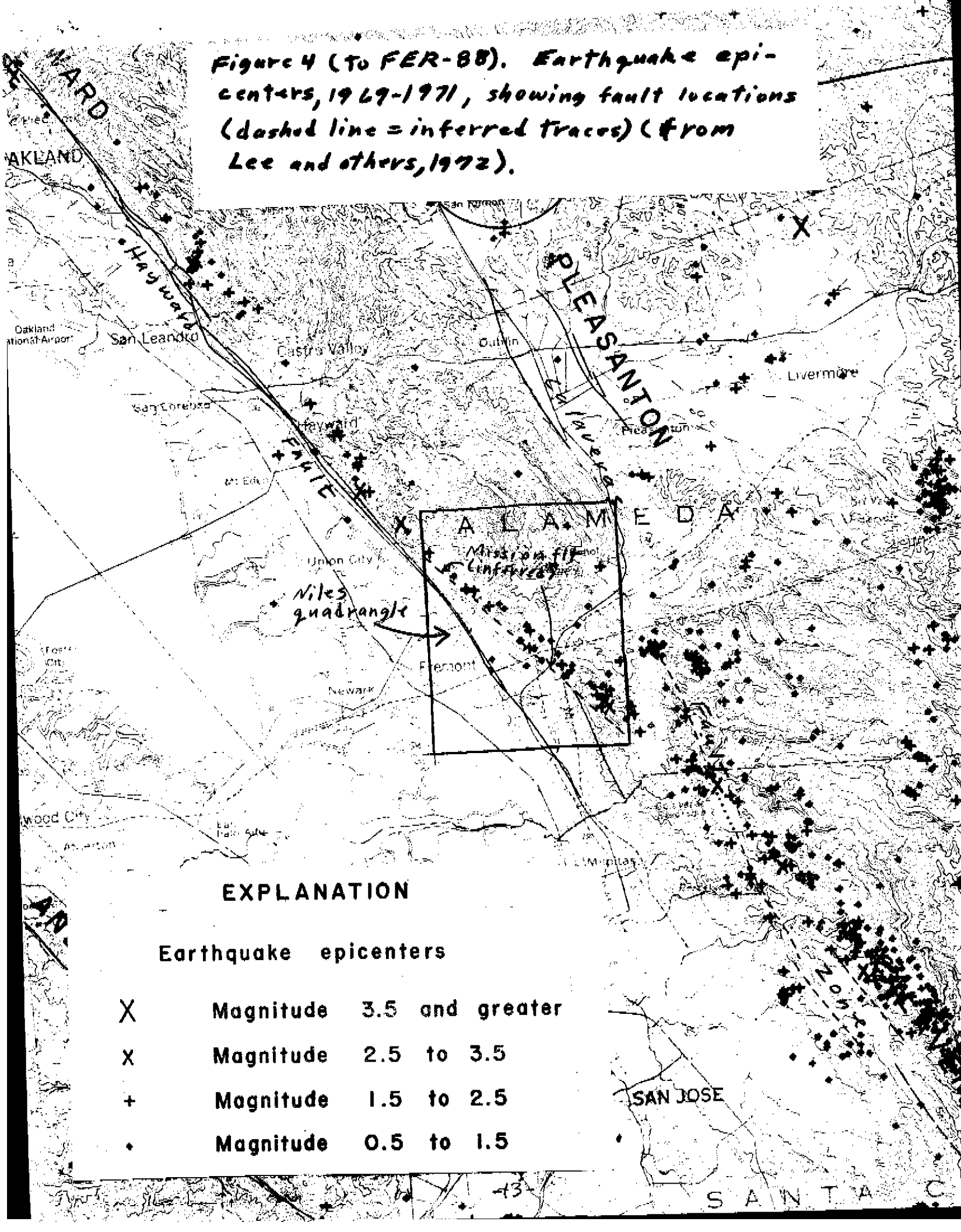
Figure 4 (to FER-88). Earthquake epicenters, 1969-1971, showing fault locations (dashed line = inferred traces) (from Lee and others, 1972).
HAYWARD
Hayward
PLEASANTON
Calaveras
FAULT
ALAMEDA
Mission (?) (inferred)
Niles quadrangle
San Leandro
Castro Valley
Hayward
Livermore
Fremont
Newark
Union City
SAN JOSE
EXPLANATION
Earthquake epicenters
X Magnitude 3.5 and greater
x Magnitude 2.5 to 3.5
+ Magnitude 1.5 to 2.5
• Magnitude 0.5 to 1.5
-43-